



DOW™ UF and RO Technology Used to Produce High Quality Water for the Beverage Industry in East Europe

At-a-Glance

LOCATION

East Europe

Project Purpose:

- Supply high-quality water for soft drink production

Design Capacity:

2,160 m³/day of RO permeate

Plant Construction:

- Veolia Water Solutions & Technologies, VWS Deutschland GmbH – BERKEFELD

System key facts:

- The plant receives raw feed water from a bore hole.
- The treatment process uses an integrated membrane system comprised of DOW™ Ultrafiltration and DOW FILMTEC™ reverse osmosis membranes.
- Intermittent sanitization of the RO system is done using the non-oxidative biocide, DBNPA.
- The RO permeate shall contain a bromide content below 0.1 mg/L.

Performance:

- Flow and rejection performances of the ultrafiltration and reverse osmosis units have been as expected and constant since startup in August 2009.
- Low and constant pressure drop and constant normalized flow of the reverse osmosis system throughout operation time.
- Intermittent sanitization of the system as well as good quality of the ultrafiltration filtrate have allowed the reverse osmosis system to remain free of particulate fouling and biofouling.
- Required removal of salt and bromide has been reliably achieved.

Time in operation:

Since August 2009

Since August 2009, an integrated membrane system using DOW™ Ultrafiltration and DOW FILMTEC™ reverse osmosis membranes produces 2,160 m³/day of high quality water for the beverage industry in East Europe.

Introduction

High quality water is required in the beverage industry, often exceeding the potable water quality standards. Bottlers usually use several filtering and other treatment techniques to remove impurities and standardize the water used to make soft drinks. Reverse osmosis (RO) system is a prevalent technology applied in the beverage industry. Nowadays, the trend in reverse osmosis pretreatment is to change from conventional filtration (usually multimedia filters) to membrane filtration, ultrafiltration (UF). The drivers for adopting UF technology as RO pretreatment are mainly the better filtered water quality and the environmental aspects, such as the ability to decrease chemical consumption and sludge quantities. In addition, UF pretreatment is becoming increasingly cost competitive.



Figure 1. Photograph of generic soft drinks. Source: iStockphoto

The plant described in this document can be considered as an example for such an application. The plant is located in East Europe, receiving raw water from a bore. The water treatment process includes an integrated membrane system using DOW™ Ultrafiltration and DOW FILMTEC™ reverse osmosis membranes. Intermittent offline sanitization of the RO system is done using the non-oxidative biocide, DBNPA (2,2, dibromo-3-nitrilo-propionamide). The product water is used for the production of soft drinks.



Figure 2. Photograph of two UF skids. Courtesy of VWS Deutschland GmbH – BERKEFELD



Plant Description

The water treatment process is presented in Figure 3. The plant receives raw feed water from a bore hole. The details of the average feed water quality are presented in Table 1. The feed water first passes through a degasifier (trickling deaerator), which removes hydrogen sulfide (H₂S) from the water. The water is then fed to a self-cleaning filter of 250µm screen size to remove big particles and safeguard the downstream ultrafiltration fibers from mechanical damage. The ultrafiltration system is divided in 4 parallel lines, each line consists of 18 **DOW™ Ultrafiltration** modules. The DOW™ Ultrafiltration module type used is the 2860 module type, featuring 51 m² of active area. The UF system is operated at a flux of 86 l/h/m² and an average recovery 92%. The UF system cleaning protocol is shown in Table 2. The UF system was oversized to account for potential events of high turbidity. After the UF process, two break tanks are used to store ultrafiltration filtrate. The UF filtrate is used to feed the RO system covered under the scope of this study and other existing treatment processes. An antiscalant is added and cartridge filters are installed before the reverse osmosis unit. These safety filters, with 5 µm pore size, provide additional protection to the high pressure pumps and reverse osmosis membranes. The reverse osmosis unit under this study is divided in four identical trains. Each train consists of seven pressure vessels in a 4:2:1 array. Each of the pressure vessels houses four **DOW FILMTEC™ SW30XLE-400i** elements. Seawater membranes are used in this application to maximize salt rejection and to safely remove the bromide content from the feed water below 0.1 mg/L. The reverse osmosis system is operated at an average system flux of 22 l/h/m² and a recovery of 80%. The Reverse Osmosis permeate is pumped into another degasifier (trickling deaerator) to remove CO₂. Additionally, a pH adjustment is conducted. Finally, the water passes through activated carbon filters, fine filters of 1 mm pore size and through an ultraviolet (UV) disinfection system before being used in the final product.

Table 1. Raw water quality range

Parameter	Unit	Raw Water Quality Range
Temperature	°C	10-18
Conductivity	µS/cm	5000-7000
pH		7.5-8.5
Total Hardness	meq/l	15
Turbidity	FNU	1-25
Bromide	mg/l	7.1-8.5
Silica (SiO ₂)	mg/L	17.2

Table 2. UF system cleaning protocol

	Backwash	Acidic CEB ¹	CIP ²
Frequency	Depends on feed water turbidity: <ul style="list-style-type: none"> • Turb: < 5 NTU: 120 min • Turb: 5-10 NTU: 72 min • Turb: 10-20 NTU: 43 min • Turb: 20-30 NTU: 33 min 	72 hours	Not needed since startup
Chemical	Every 12th backwash 10 ppm NaOCl is added	600 mg/l of HCl	

¹CEB: Chemical Enhanced Backwash
²CIP: Cleaning In Place

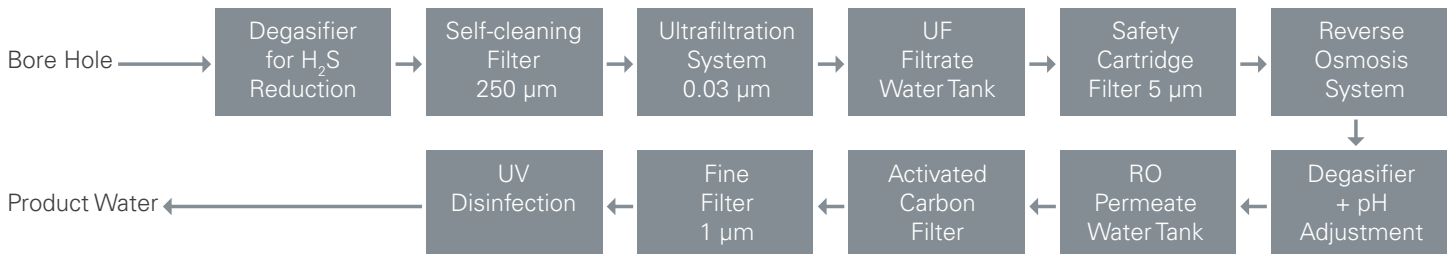


Figure 3. Process flow diagram of the plant

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Table 3. Summarized UF and RO system information

Unit	Total Capacity (m ³ /h)	Operating Flux (l/m ² h)	Recovery %	Number of Trains/Stages	Product Installed	Total Number of Modules
Ultrafiltration	316 ^a	86	92 ^b	4	DOW™ UF 2860 Module Type	72
Reverse Osmosis	90	22	80	4/3	DOW FILMTEC™ SW30XLE-400i	112

^aUF gross filtrate flow. The downstream RO system under this study is fed with only a part of the total UF filtrate flow (112.5 m³/h)

^bUF recovery (related to UF feed)% of all three UF trains on duty: UF filtrate net flow / UF Feed flow · 100



Figure 4. Photograph of an RO rack. Courtesy of WWS Deutschland GmbH – BERKEFELD

Plant Performance

During the first eight months of operation the ultrafiltration membranes DOW™ UF SFP2860 have been operating at the design flux of 86 l/h/m². In Figure 5 the normalized TMP as well as the normalized permeability are depicted for the time frame November 2009–March 2010. During this period the permeability faced some fluctuation reaching values as high as 160 l/h/m². During February–March 2010 the normalized permeability was relatively stable at high values around 118 l/h/m². The designed start-up transmembrane pressure (TMP) was 0.5 bar and after eight months of operation the TMP is found stable at around 0.7–0.8 bar. The current backwash and CEB programs are effective in maintaining the TMP and a relatively high permeability. No Cleaning In Place (CIP) operations have been required during these first eight months of operation.

Additionally, the UF filtrate water quality has been constant and of good quality. UF filtrate turbidity values have been determined below 0.1 NTU.

The reverse osmosis membranes did not need any CIP during the first 8 months of operation. However, each RO line receives a daily offline flushing with the non-oxidizing biocide DBNPA in order to prevent the occurrence of biogrowth on the membranes surface.

The normalized permeate flow (Figure 6) has been very constant at around 23 m³/h, as expected by design. The permeate quality has been good and stable. The normalized salt passage has been as expected at around 0.89% (Figure 6). Additionally, bromide concentration in the permeate stream has been always around 0.05 mg/l, safely below the maximum limit of 0.10 mg/l. The normalized pressure drop across the three stages has been stable at a low level of around 1.5 bar throughout the reported time of operation (Figure 7). This is an indication of absence of particulate or biofouling on the RO membranes. This can be mainly attributed to the good quality feed water provided by the ultrafiltration membranes and to the good operation practices as well as the anti-biofouling preventive actions done by the operators.

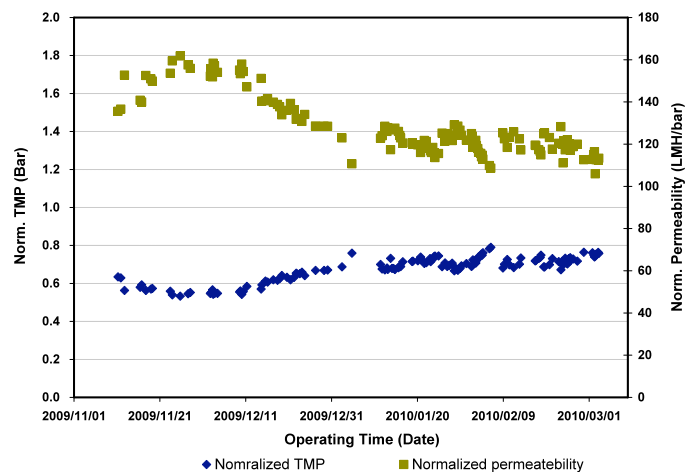


Figure 5. Ultrafiltration performance: Normalized TMP and Normalized permeability

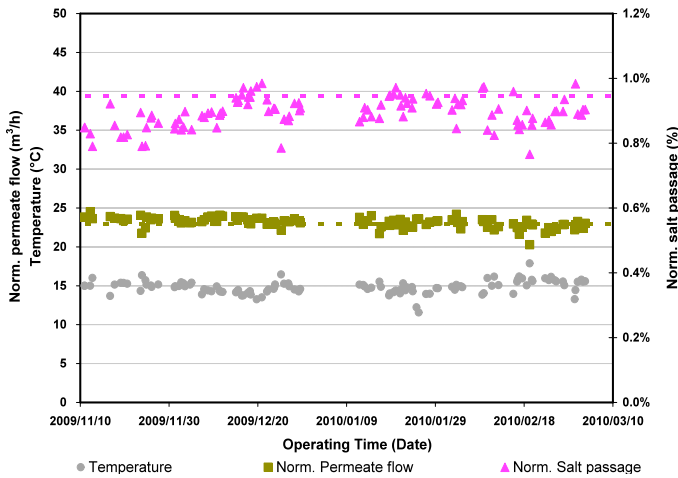


Figure 6. RO performance: Normalized permeate flow and normalized salt passage

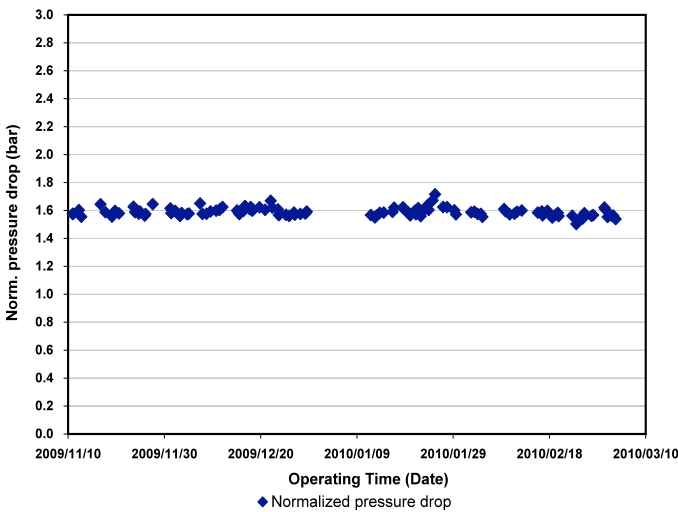


Figure 7. RO performance: Normalized pressure drop across the three stages

CONCLUSION

Since August 2009, the plant reliably supplies 2,160 m³/day of high quality water for a soft drink production factory located in Eastern Europe. The system uses an integrated membrane system including DOW™ Ultrafiltration 2860 modules and DOW FILMTEC™ SW30XLE-400i reverse osmosis membranes. Seawater type membrane elements are used to maximize salt rejection and safely remove bromide from the water. The flow and rejection performances of the UF and RO units have been as expected and constant since the start-up. Additionally, the good UF filtrate quality as well as the intermittent offline sanitization of the system by DBNPA enabled to maintain the RO system free of particulate fouling and biofouling. This has been demonstrated by the low and constant pressure drop and the constant normalized flow of the RO system throughout the operation time.

For more information about DOW Ultrafiltration and FILMTEC™ reverse osmosis membranes, including all scientific data and supporting reference materials, call the Dow Water & Process Solutions business:

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